EXAMINED UTILITY MODEL PUBLICATION NO. 48-7051

TRANSPARENT SCREEN

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TRANSPARENT SCREEN

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[There are no amendments.]

Specification

Title of the design

Transparent screen

Brief description of figures

Fig. 1 is a partial enlarged cross-section view showing the shape of the transparent screen cross-section of the present design, Fig. 2 is a graph that shows the relationship between transmittance T and diffusion angle θ of the transparent screen of the present design, and Fig. 3 is a graph that shows the results of measurement of the transparent screen of the present design.

Detailed description of the design

The present design pertains to an improvement of transparent screens capable of providing a wide-angle light diffusion property while good image-formation and a bright screen are retained, through arrangement of a fine particle non-reflective surface on one side of a diffusion sheet made of a thin plastic material with a light diffusion material uniformly mixed in it and forming a wave-like lenticular pattern on the other side.

The present design is explained in further detail with the drawings below. In Fig. 1, 1 is transparent screen produced by forming a fine particle non-reflective surface 3 on one side of a sheet-like diffusion layer 2 made of a thin plastic material with a light diffusion material, such as anhydrous magnesium silicate, uniformly mixed in it to form a light transmittance of approximately 60% and forming a lenticular surface 4 with lenses having identical radii of curvature that inflect at a specific interval on the other side in the direction perpendicular to the screen (horizontal direction in the fig.) to form a wave-like pattern.

In the screen having the above-mentioned structure, when one of lenticular lenses 4 is regarded as a convex lens, the angle of incidence of light that enters the spherical surface v_1 from the projector is β, the radius of curvature of the spherical surface of the lenticular surface 4 is r

and the pitch of the lenticular surface is P as shown in Fig. 1,

$$\sin \beta = P/2r$$

and the value obtained is defined as K. The angle formed by the exit beam of light having a height h for the ν_1 surface of the lens and parallel to the optical axis and the optical axis is defined as θ and is used as the diffusion angle. In the same manner, when the diffusion angle for the angle of incidence for height $h + \Delta h$ is defined as θ', $\Delta\theta = |\theta'-\theta|$ can be achieved, and furthermore, when the quantity of light at the angle of incidence of height h per unit height is defined as I(h), the quantity of light of the exit beam per unit value is defined as I'(h), and transmittance is defined as T, the relationship shown below can be established between the quantity of light entering through the interval Δh and the quantity of light exiting at an angle of $\Delta\theta$.

$$I(h)\cdot\Delta h\cdot T = I'(\theta)\cdot\theta$$

Therefore,

$$I'(\theta) = I(h)\cdot T\cdot(\Delta h/\Delta\theta) \quad \ldots\ldots\ldots (1)$$

Based on the relationship shown above, for example, when vinyl chloride is selected as a material for the diffusion layer, the relationship between the transmittance T and diffusion angle θ for K with a refractive index of 1.5 is shown in Fig. 2. In this case, the concave lens is the same as the convex lenticular surface when the radius of curvature of the spherical surface is r for the concave surface of the lenticular surface.

It is desirable when a bright and clear image is obtained at an angle of view of at least 15 to 20 degrees in the vertical direction and approximately 35 to 40 degrees in the horizontal direction of the projection screen, and in order to obtain an optimum screen within the above-mentioned practical angle of view, for example, in order to achieve diffusion angle θ of 37 degrees, K=0.85 is obtained from equation (1) or Fig. 2.

On the other hand, the beam of light that travels along the optical axis of the lenticular

surface advances directly inside the diffusion layer and is identified as a bright light by the viewer and projection performance is inhibited; thus, it is necessary to establish the pitch of the lenticular surface at an appropriate degree. In general, the visual limit of distinguishing two lines accurately is 20", thus, when the distance between the screen and the viewer is L m/m, P = L x 0.000097 (rad) = approx. L x 10^{-4} Therefore, in order to achieve an optimum screen at an angle of view of 37 degrees and distance between the screen and viewer of 2 m, a lenticular pitch of P=0.2 mm and radius of curvature of r=0.12 mm are suitable.

[p. 2]

Fig. 3 is a graph where a vertical incident beam of light is applied to the screen, and the angle of the transmitted light in the same direction as the incident light is defined 0 degrees and the angle of light on a flat surface that includes transmitted light of angle 0° is changed from 0° to 50° and the quantity of light at each angle is measured and the quantity of light at 0° angle is shown as 100; curve A shows the characteristic in the horizontal direction of the screen and curve C shows characteristic in the vertical direction of the screen.

According to the present design, a significant increase in the diffusion property in the horizontal direction of the screen is possible based on the specific shape of the lenticular surface, and a narrow angle of view is required in the vertical direction; thus, the mixing ratio of the diffusion material can be reduced, and the thickness of the diffusion layer can be reduced, and a transparent screen having excellent light transmittance and good image-formation properties with an absence of nonuniform colors can be produced.

Claim of the design

A transparent screen produced by forming a wave-like pattern having identical radii of curvature on one or both surfaces of a sheet-like diffusion layer made of a thin plastic material with a fine diffusion material uniformly mixed in so as to form light transmittance of

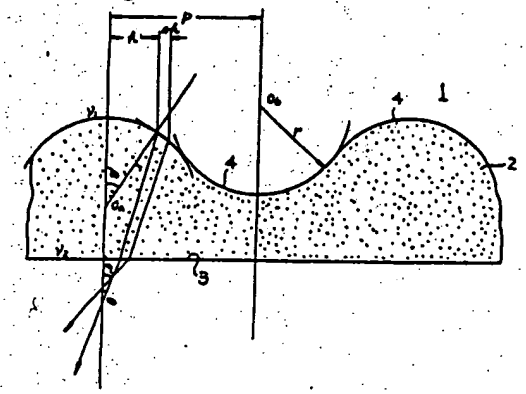
approximately 60%, and a non-reflective surface of fine particles is formed on the other surface and having a lenticular wave-like pattern of K = 0.3 to 0.9 and P approx. = L x 10^{-4} when the ratio of the pitch of the aforementioned lenticular surface P (mm) and the radius of curvature r (mm) is p/2r=K and the distance between the screen and viewer is L (mm).

References cited

JP Sho 28-1528 (J, U)

British Patent No. 969071

Fig. 1



[p. 3]

Fig. 2

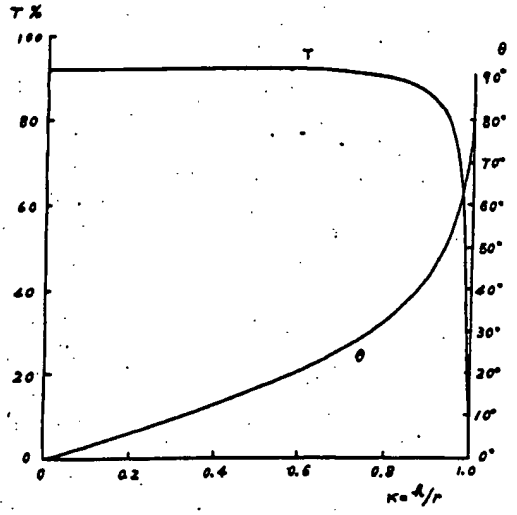
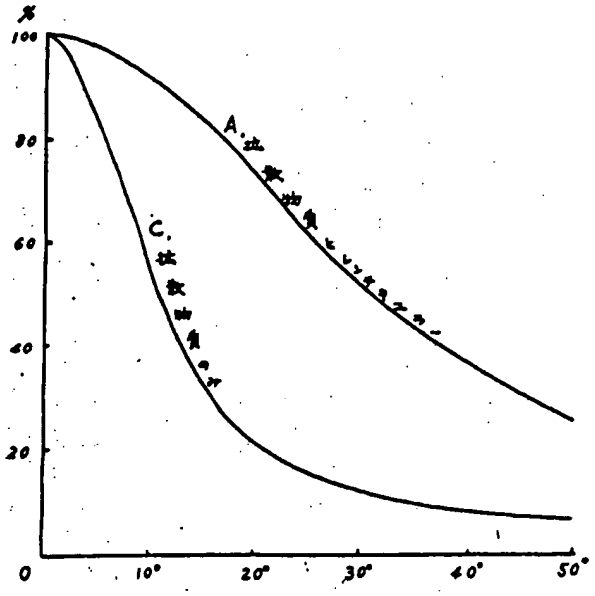


Fig. 3



Vertical axis: diffusion quantity of light

Horizontal axis: Angle

A: Diffusion material and lenticular surface

B: Diffusion material alone

⑤1 Int.Cl.
G 03 b 21/60

⑤2日本分類
103 D 81

⑲日本国特許庁

⑪実用新案出願公告
昭48－7051

実用新案公報

㊹公告 昭和48年(1973) 2月23日

（全 3 頁）

1

⑤4透視スクリーン

㉑実　　願　昭43－109037
㉒出　　願　昭43（1968）12月16日
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図面の簡単な説明

第1図は、本案による透視スクリーンの断面形状を示す部分拡大断面図、第2図は、本案透視スクリーンの透過率T及び拡散角θの関係を示すグラフ、第3図は本案スクリーンの測定結果を表わすグラフである。

考案の詳細な説明

本案は、光拡散物質を均一に混入した薄い可塑性材料より成る拡散層のシートの一面に微粒子状の無反射面を、他面にはレンチキユラーを凹凸に波形状に形成することにより、良好な結像性能と明るい画面を保持したまま、広角度の光拡散特性を得ることのできる透視スクリーンの改良に関するものである。

以下図面に従つて本案を説明すると、第1図において、1は、例えば無水珪酸マグネシウム等の光拡散物質を光透過率が約60%となるように均一に混入した可塑性材料より成るシート状の拡散層2に、その一面には微粒子状の無反射面3を、他面には一定間隔で反曲する同一曲率半径のレンチキユラー4を波形状にスクリーンの上下方向（図の左右）に形成した透視スクリーンである。

かかる構成のスクリーンにおいて、第1図に示すように、レンチキユラー4の一つを凸レンズと考え、映写機から球面ν_1へ入る光の入射角をβ、レンチキユラー4の球面の曲率半径をr、レンチキユラー4のピツチをPとすると、

$$\sin\beta=\frac{P}{2r}$$

2

この値をKとする。レンズのν_1面に対して高さhの、光軸に平行な光線の射出光線と、光軸とのなす角をθとし、これを拡散角とする。同様に、高さh＋△hの入射光に対する拡散角をθ'とすれば、$\triangle\theta=|\theta'-\theta|$となり、又、高さhの入射光の単位高さ当りの光量をI(h)、射出光線の単位価度当りの光量を$I'(\theta)$とし、透過率をTとすれば、幅△hに入射する光量と角度△θで射出する光量との間には次の関係が成立する。

$$I(h).\triangle h.T=I'(\theta).\triangle\theta$$

従つて、

$$I'(\theta)=I(h)\cdot T\cdot\frac{\triangle h}{\triangle\theta} \quad \cdots\cdots\cdots\cdots \quad (1)$$

これらの関係から、拡散層の材料として例えば塩化ビニールを選んだ場合、その屈折率を1.5としてKに対する透過率T及び拡散角θの関係を求めたものが第2図である。この場合、レンチキユラーの凹面についても、第1図において球面の曲率半径rを負として凹レンズを考えれば凸面のレンチキユラーと同様に考えることができる。

映写スクリーンは、少なくともその上下方向においては15°～20°、又、左右方向においては35°～40°程度の視角範囲内において鮮明で明るい像が得られることが望ましいので、この実用的視角範囲内において最適のスクリーンを得るため、例えば、拡散角θを3°とするには、(1)式の関係或るいは第2図よりK＝0.85を得る。

一方、レンチキユラーの光軸に沿つて進む光線は、拡散層内を直進し、観視者に輝線として識別され、映写効果を害するので、レンチキユラーのピツチPを適当に定める必要がある。一般に眼の二線識別精度は20″とされているので、スクリーンと観視者の間の距離をLm／mとすれば、P＝L×0.000097（rad）≒L×10⁻⁴となる。これらのことから、例えば、視角範囲3°、スクリーンと観視者の間の距離2mにおいて最適のスクリーンを得るには、レンチキユラーのピツチP＝0.2㎜、曲率半径r＝0.12㎜とすればよいことがわかる。

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第3図は、このスクリーンに垂直な入射光を当て、入射光と同一方向に透過する透過光の角度を0°とし、角度0°の透過光を含む平面上で光線の角度を0°から50°まで変化させ、各々の角度における光量を測定したもので、角度0°のときの光量を100として表わしたグラフであり、曲線Aはスクリーンの左右方向の特性を、曲線Cは上下方向の特性を示している。

本案によれば、スクリーンの左右方向の拡散性能がレンチキユラーの特定の形状設定により大きく高められ、上下方向に関しては、実際上狭い視角範囲しか要求されないため、拡散物質の混入量を少なくでき、拡散層を薄くすることができ、実用上充分な視角範囲内で透光性、結像性が良く、色調にむらのない透視スクリーンを得ることができる。

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(57)実用新案登録請求の範囲

微細な拡散物質を透過率が60%以上となるように均一に混入した可塑性材料より成るシート状の拡散層の一面又は両面に互いに接する、同一曲率半径の凹凸のレンチキユラー波状面を形成し、他面に微粒子の無反射面を設け、前記レンチキユラーのピッチP（㎜）と曲率半径r（㎜）の比をp／2r＝K、スクリーンと観視者の間の距離をL（㎜）とするとき、K＝0.3～0.9、P≒L×10⁻⁴によつて定められる前記レンチキユラー波状面を有する透視スクリーン。

(56)引用文献

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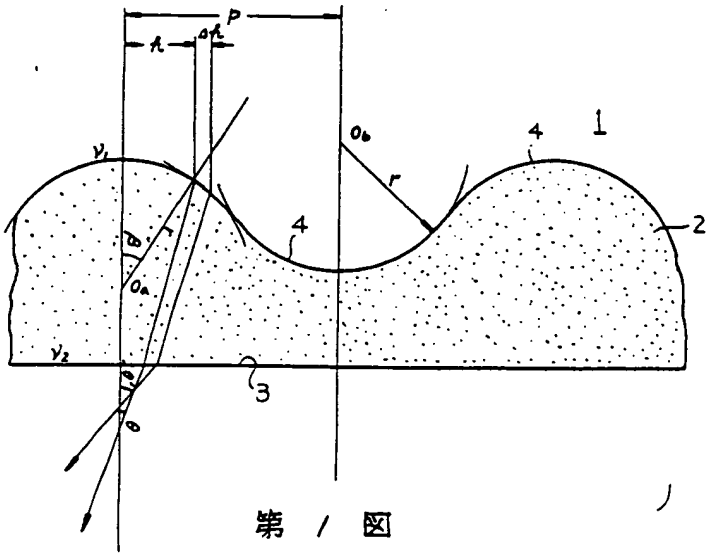
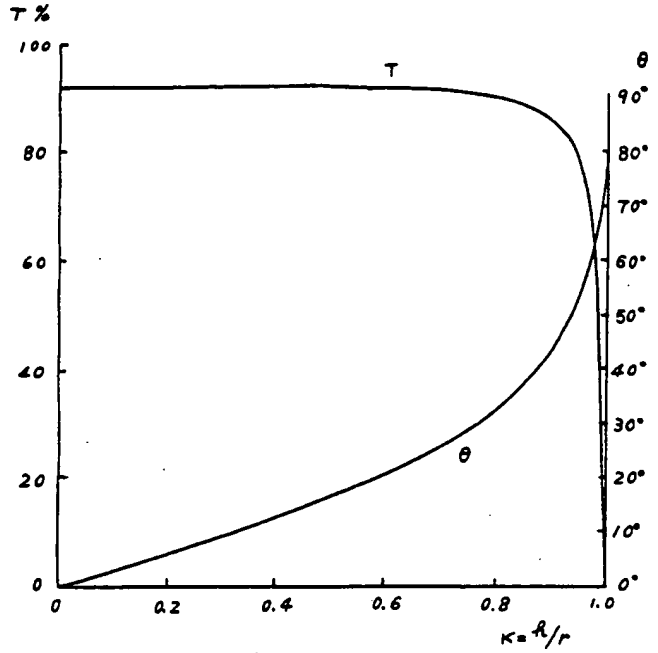
英国特許　969071



第1図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0.4
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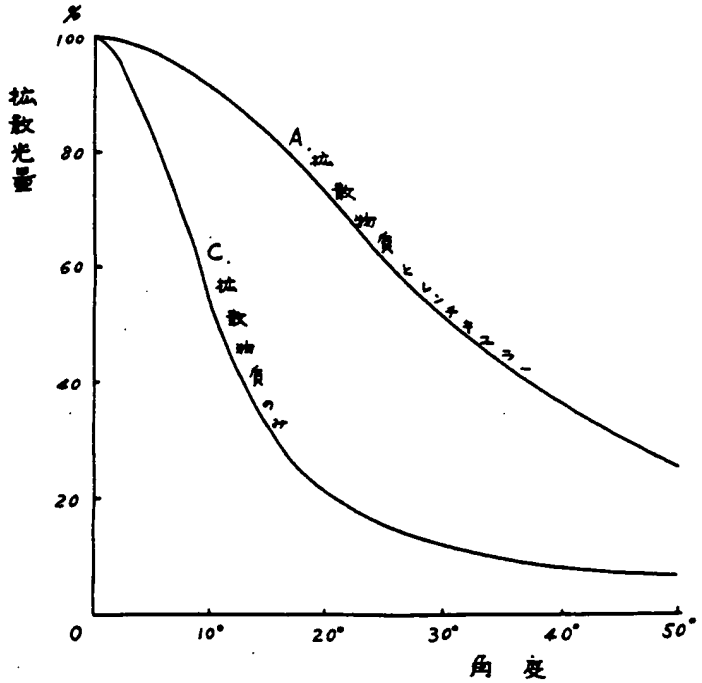
κ=R/r

第 2 図


%
100
80
60
40
20
0
拡散光量
A. 拡散物質ヒレンチキュラー
C. 拡散物質のみ
10°
20°
30°
40°
50°
角度

第 3 図

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